

CLAIMS

What is claimed is:

1. A fuel cell system, comprising:
 - a fuel cell stack;
 - at least one sensor proximate the fuel cell stack to detect an operating parameter of the fuel cell stack;
 - at least one actuator; and
 - a microcontroller coupled to receive signals from the sensor and to provide signals to the actuator and configured to perform a self test by:
 - setting a set of bits in a number of general registers of the microcontroller to a predefined pattern;
 - complementing the set of bits of one of the general registers;
 - copying the set of bits from the one of the general registers to a special register of the microcontroller;
 - determining if each bit in the set of bits copied to the special register was complemented; and
 - producing a notification signal based on the determination.
2. The fuel cell system of claim 1 wherein the microcontroller is further configured to perform at least a portion of the self test at least once while the fuel cell system is in a starting state prior to operation of the fuel cell system and at least once while the fuel cell system is in a running state during operation of the fuel cell system.
3. The fuel cell system of claim 1 wherein the microcontroller is further configured to perform the self test by:
 - for each general register other than the one of the general registers,
 - copying the set of bits from the other general register to the special register;

determining if each bit in the set of bits copied to the special register from the other general register matches the corresponding bit in the predefined pattern; and
producing a notification signal based on the determination.

4. The fuel cell system of claim 1 wherein the microcontroller is further configured to perform the self test by:

for each general register other than the one of the general registers,
copying the set of bits from the other general register to the special register; and

determining if each bit in the set of bits copied to the special register from the other general register matches the corresponding bit in the predefined pattern;

complementing the previously complemented set of bits in the one of the general registers;

copying the set of bits from the one of the general registers to the special register of the microcontroller;

determining if each bit in the set of bits copied to the special register from the one of the general registers matches the predefined pattern; and

producing a notification signal based on the determinations.

5. The fuel cell system of claim 1 wherein the microcontroller is further configured to perform the self test by:

for each general register other than the one of the general registers,
copying the set of bits from the other general register to the special register; and

determining if each bit in the sets of bits copied to the special register from the other general register matches the corresponding bit in the predefined pattern;

complementing the previously complemented set of bits in the one of the general registers;

copying the set of bits from the one of the general registers to the special register of the microcontroller;

determining if each bit in the set of bits copied to the special register from the one of the general registers matches the predefined pattern;

for each of the other of the general registers,

copying the set of bits from the other general register to the special register; and

determining if each bit in the set of bits copied to the special register from the other general register matches the corresponding bit in the predefined pattern; and

producing a notification signal based on the determinations.

6. The fuel cell system of claim 1 wherein the predefined pattern alternates the setting of each next successive bit.

7. The fuel cell system of claim 1, further comprising:

successively repeating the acts of claims 1 and 5 for each of the general registers as the one of the general register.

8. A controller for controlling an operation of a fuel cell system, the controller configured to:

set a set of bits in a number of general registers of the controller to a predefined pattern;

complement the set of bits of one of the general registers;

copy the set of bits from the one of the general registers to a special register of the controller; and

determine if each bit in the set of bits copied to the special register was complemented.

9. The controller of claim 8, further configured to:

for each of the other of the general registers, copy the set of bits from the other general register to the special register;

determine if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern; and

produce a notification signal based on the determination.

10. The controller of claim 8, further configured to:

for each of the other of the general registers, copy the set of bits from the other general register to the special register;

determine if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern;

complement the previously complemented set of bits in the one of the general registers;

copy the set of bits from the one of the general registers to the special register of the controller;

determine if each bit in the set of bits copied to the special register matches the predefined pattern; and

produce a notification signal based on the determinations.

11. The controller of claim 8, further configured to:

for each of the other of the general registers, copy the set of bits from the other general register to the special register;

determine if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern;

complement the previously complemented set of bits in the one of the general registers;

copy the set of bits from the one of the general registers to the special register of the controller;

determine if each bit in the set of bits copied to the special register matches the predefined pattern;

for each of the other of the general registers, copy the set of bits from the other general register to the special register;

determine if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern; and

producing a notification signal based on the determinations.

12. A controller for controlling an operation of a fuel cell system, the controller configured to:

perform at least a portion of one self test of the general registers of the controller while the fuel cell system is in a starting state prior to operation of the fuel cell system; and

perform at least a portion of one self test of the general registers of the controller while the fuel cell system is in a running state during operation of the fuel cell system.

13. The controller of claim 12 wherein the controller is configured to perform the self test by:

setting a set of bits in a number of general registers of the controller to a predefined pattern;

complementing the set of bits of one of the general registers;

copying the set of bits from the one of the general registers to a special register of the controller; and

determining if each bit in the set of bits copied to the special register was complemented.

14. The controller of claim 12 wherein the controller is configured to perform the self test by:

setting a set of bits in a number of general registers of the controller to a predefined pattern;

complementing the set of bits of one of the general registers;

copying the set of bits from the one of the general registers to a special register of the controller;

determining if each bit in the set of bits copied to the special register was complemented;

for each of the other of the general registers, copying the set of bits from the other of the general register to the special register;

determining if each bit in the sets of bits of the copied to the special register from the other general registers matches the corresponding bit in the predefined pattern;

complementing the set of bits in the one of the general registers;

copying the set of bits from the one of the general registers to the special register of the controller;

determining if each bit in the set of bits copied to the special register matches the predefined pattern;

for each of the other of the general registers, copying the set of bits from the other of general register to the special register;

determining if each bit in the sets of bits of the copied to the special register from the other general registers matches the corresponding bit in the predefined pattern; and

producing a notification signal based on the determination

15. A controller readable memory carrying instructions for causing a controller to perform a self test, by:

setting a set of bits in a number of general registers of the controller to a predefined pattern;

complementing the set of bits of one of the general registers;

copying the set of bits from the one of the general registers to a special register of the controller; and

determining if each bit in the set of bits copied to the special register was complemented.

16. The controller readable memory of claim 15 carrying instructions for causing the controller to perform the self test, further by:

for each of the other of the general registers, copying the set of bits from the other general register to the special register;

determining if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern; and

producing a notification based on the determination.

17. The controller readable memory of claim 15 carrying instructions for causing the controller to perform the self test, further by:

for each of the other of the general registers, copying the set of bits from the other general register to the special register;

determining if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern;

complementing the previously complemented set of bits in the one of the general registers;

copying the set of bits from the one of the general registers to the special register of the controller;

determining if each bit in the set of bits copied to the special register from the one of the general registers matches the predefined pattern; and

producing a notification based on the determinations.

18. The controller readable memory of claim 15 carrying instructions for causing the controller to perform the self test, further by:

for each of the other of the general registers, copying the set of bits from the other general register to the special register;

determining if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern;

complementing the previously complemented set of bits in the one of the general registers;

copying the set of bits from the one of the general registers to the special register of the controller;

determining if each bit in the set of bits copied to the special register from the one of the general registers matches the predefined pattern;

for each of the other of the general registers, copying the set of bits from the other general register to the special register;

determining if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern; and

producing a notification based on the determinations.

19. A controller readable memory carrying instructions for causing a controller to:

perform at least a portion of one self test of the controller while the fuel cell system is in a starting state prior to operation of the fuel cell system; and

perform at least a portion of one self test of the controller while the fuel cell system is in a running state during operation of the fuel cell system.

20. The controller readable memory of claim 19 wherein the instructions cause the controller to perform the self test, by:

setting a set of bits in a number of general registers of the controller to a predefined pattern;

complementing the set of bits of one of the general registers;

copying the set of bits from the one of the general registers to a special register of the controller; and

determining if each bit in the set of bits copied to the special register was complemented.

21. The controller readable memory of claim 19 wherein the instructions cause the controller to perform the self test, by:

setting a set of bits in a number of general registers of the controller to a predefined pattern;

complementing the set of bits of one of the general registers;

copying the set of bits from the one of the general registers to a special register of the controller;

determining if each bit in the set of bits copied to the special register was complemented;

for each of the other of the general registers, copying the set of bits from the other general register to the special register;

determining if each bit in the sets of bits of the copied to the special register from the other general registers matches the corresponding bit in the predefined pattern;

complementing the previously complemented set of bits in the one of the general registers;

copying the set of bits from the one of the general registers to the special register of the controller;

determining if each bit in the set of bits copied to the special register from the one of the general registers matches the predefined pattern;

for each of the other of the general registers, copying the set of bits from the other general register to the special register;

determining if each bit in the sets of bits copied to the special register from the other general registers matches the corresponding bit in the predefined pattern; and

producing a notification signal based on the determination.

22. A method of operating a controller in a fuel cell system, comprising:

setting a set of bits in each of a number of general purpose registers of the controller to a predefined pattern;

successively, for each of the general propose registers of the controller,

complementing the set of bits of the general purpose register;
copying the set of bits from the general purpose register to a special purpose register of the controller; and
determining if the bits copied to the special purpose register are complemented with respect to the predefined pattern.

23. The method of claim 22 wherein the predefined value alternates the value of adjacent bits in the set of bits.

24. The method of claim 22, further comprising:
for each of general purpose registers of the controller,
complementing the complemented set of bits of the general purpose register;
copying the set of bits from the general purpose register to the special purpose register of the controller; and
determining if bits copied to the special purpose register match the predefined pattern.

25. The method of claim 22, further comprising:
successively following each of the determining if the bits copied to the special purpose register are complemented with respect to the predefined pattern,
for each of the general purpose registers not having complemented bits,
copying the set of bits from the general purpose register to the special purpose register; and
determining if the bits copied to the special purpose register match the predefined pattern.

26. The method of claim 22 wherein the acts are performed while the fuel cell system is in a running state during operation of the fuel cell system.

27. The method of claim 22 wherein the acts are performed at least once while the fuel cell system is in a starting state prior to operation of the fuel cell system and at least once while the fuel cell system is in a running state during operation of the fuel cell system.

28. A method of operating a controller in a fuel cell system, comprising:
performing at least a portion of one self test of the controller while the fuel cell system is in a starting state prior to operation of the fuel cell system; and
performing at least a portion of one self test of the controller while the fuel cell system is in a running state during operation of the fuel cell system.

29. The method of claim 28 wherein performing a self test of the controller includes:

setting a set of bits in a number of general purpose registers of the controller to a predefined pattern;
complementing the set of bits of one of the general purpose registers;
copying the set of bits from the one of the general purpose registers to a special purpose register of the controller; and
determining if each bit in the set of bits copied to the special purpose register from the one of the general purpose registers was complemented.

30. The method of claim 28 wherein performing a self test of the controller includes:

setting a set of bits in a number of general purpose registers of the controller to a predefined pattern;
complementing the set of bits of one of the general purpose registers;
copying the set of bits from the one of the general purpose registers to a special purpose register of the controller;
determining if each bit in the set of bits copied to the special purpose register from the one of the general purpose registers was complemented;

for each of the other of the general purpose registers, copying the set of bits from the other general purpose register to the special purpose register;

determining if each bit in the sets of bits of the copied to the special purpose register from the other general purpose registers matches the corresponding bit in the predefined pattern; and

producing a notification signal based on the determination.

31. The method of claim 28 wherein performing a self test of the controller includes:

setting a set of bits in a number of general purpose registers of the controller to a predefined pattern;

complementing the set of bits of one of the general purpose registers;

copying the set of bits from the one of the general purpose registers to a special purpose register of the controller;

determining if each bit in the set of bits copied to the special purpose register from the one of the general purpose registers was complemented;

for each of the other of the general purpose registers, copying the set of bits from the other general purpose register to the special purpose register;

determining if each bit in the sets of bits of the copied to the special purpose register from the other general purpose registers matches the corresponding bit in the predefined pattern;

complementing the previously complemented set of bits in the one of the general purpose registers;

copying the set of bits from the one of the general purpose registers to the special purpose register of the controller;

determining if each bit in the set of bits copied to the special purpose register from the one of the general purpose registers matches the predefined pattern; and

producing a notification signal based on the determination.

32. The method of claim 28 wherein performing a self test of the controller includes:

setting a set of bits in a number of general purpose registers of the controller to a predefined pattern;

complementing the set of bits of one of the general purpose registers;

copying the set of bits from the one of the general purpose registers to a special purpose register of the controller;

determining if each bit in the set of bits copied to the special purpose register from the one of the general purpose registers was complemented;

for each of the other of the general purpose registers, copying the set of bits from the other general purpose register to the special purpose register;

determining if each bit in the sets of bits copied to the special purpose register from the other general purpose registers matches the corresponding bit in the predefined pattern;

complementing the previously complemented set of bits in the one of the general purpose registers;

copying the set of bits from the one of the general purpose registers to the special purpose register of the controller;

determining if each bit in the set of bits copied to the special purpose register from the one of the general purpose registers matches the predefined pattern;

for each of the other of the general purpose registers, copying the set of bits from the other general purpose register to the special purpose register;

determining if each bit in the sets of bits copied to the special purpose register from the other general purpose registers matches the corresponding bit in the predefined pattern; and

producing a notification signal based on the determination.